

Gender Influence on Statistics Anxiety among Graduate Students

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Abstract: The present study was conducted to further explore gender-based differences in the experience of statistics anxiety among graduate students. A sample of 75 graduate students from a mid-sized research university in the southeastern United States were recruited to participate in a survey concerning statistics anxiety. Data were analyzed using multivariate analysis of covariance and discriminant analysis. Using the Statistics Anxiety Rating Scale, students' statistics anxiety was measured. After accounting for age, the findings revealed a significant gender difference in statistics anxiety. A significant covariate effect of age indicated that older graduate students reported experiencing higher levels of anxiety as compared to their younger peers. Age accounted for 21% of variance in the combined statistics anxiety subscales. Analysis further revealed that males experienced higher levels of anxiety when seeking statistics help from a fellow student or a professor than did females. Implications for the design of statistics courses are discussed.

Keywords: *Age; Gender; Graduate students; Statistics anxiety*

Introduction

Statistics is considered to constitute an essential knowledgebase in many fields, including the behavioral sciences and education. A known impediment to mastery of statistical concepts and procedures is the anxiety that many students experience while receiving instruction in statistics. Anxiety is documented as hindering content mastery in many areas including mathematics (Galla & Wood, 2012; Luttenberger et al., 2018; Paechter et al., 2017). Anxiety is a negative emotional state characterized by excessive worry, apprehension, tension, and resulting in difficulties in deploying and maintaining (Brandish & Baldwin, 2012; Jehu, 1970). Anxiety is often accompanied by feelings of low competence about one's own abilities (Brandish & Baldwin, 2012). These authors postulate that feelings

of low competence concerning a student's self-appraisal of their own abilities produce a state of negative emotional arousal. Further, students who have low self-efficacy beliefs regarding statistics mastery are at risk of experiencing statistics-related anxiety (Hsu et al., 2009).

Studies concerned with statistics anxiety suggest that many if, indeed, not most students experience at least some level of anxiety concerning statistics (Baloğlu et al., 2011; Onwuegbuzie & Wilson, 2003). This is known to be a common issue among students enrolled in behavioral sciences courses and especially those in psychology, education, and sociology (Chew & Dillon, 2014b; Smith & Capuzzi, 2019; Onwuegbuzie & Wilson, 2003; Pan & Tang, 2005; Macher et al., 2013) in which at least one course in statistics is mandatory (Mondéjar-Jiménez & Vargas-Vargas, 2010; Pan & Tang, 2005). Moreover, Chew and Dillon (2014b) noted that many undergraduate honors programs have considered statistics as an entry

qualification. These same authors found that students often did not appreciate the importance of statistics and often reported having negative experiences, hence the anxiety (Chew & Dillon, 2014b). Statistics anxiety may hinder a student's acquisition of knowledge and skills that could negatively impact their future careers (Mji, 2009; Rodarte-Luna & Sherry, 2008).

Like other forms of anxiety, statistics anxiety is considered to have both cognitive and affective components (Lavasani et al., 2011, 2014). Many definitions have been proposed for statistics anxiety which are rather similar in nature. For example, according to Cruise et al. (1985) statistics anxiety refers to "the feelings of anxiety encountered when taking a statistics course or doing statistical analyses" (p. 92). Another definition is "the apprehension that occurs when an individual is exposed to statistics content, problems, instructional situations, or evaluative contexts" (Macher et al., 2012, p. 484). Further, according to Chew and Dillon (2014b) anxiety towards statistics consists of:

a negative state of emotional arousal experienced by individuals as a result of encountering statistics in any form and at any level; this emotional state is preceded by negative attitudes toward statistics and is related to but distinct from mathematics anxiety. (p. 199)

Cruise et al. (1985) developed an instrument to measure statistics anxiety comprised of six dimensions: *Worth of Statistics*, *Interpretation Anxiety*, *Test and Class Anxiety*, *Computational Self-concept*, *Fear of Asking for Help*, and *Fear of Statistics Teachers*.

Many factors are known to be associated with statistics anxiety. Mathematics anxiety, previous mathematics experience, previous statistics experience, misconception about statistics, personality traits, and attitudes toward statistics instructors are some of the factors known to contribute to statistics anxiety (Baloğlu, 2003; Chew & Dillon, 2014a; Dykeman, 2011; Faber & Drexler, 2020; Paechter et al., 2017; Pan & Tang, 2005).

Research has suggested the existence of three antecedent categories that can give rise to statistics anxiety. These are 1. situation-related antecedents which involve the context surrounding the anxiety-provoking stimulus (e.g. prior statistics knowledge, prior statistics and mathematics grades, course status); 2. dispositional antecedents, factors that relate to personality and how an individual characteristically approaches challenging tasks (e.g. procrastination, self-esteem, perfectionism); and 3. environment antecedents which include such factors as academic major, nationality, culture (Chew & Dillon, 2014b; Macher et al., 2013; Onwuegbuzie & Wilson, 2003). Researchers have been using these antecedents to help explore the conditions that give rise to statistics anxiety. For example, procrastination has been found to be positively related with statistics anxiety (Rodarte-Luna & Sherry, 2008). Some of these antecedents could not be experimentally manipulated due to their inherent characters but are amenable to exploration by means of correlational methodologies. These are reviewed below.

Personal Characteristics

Age, gender, and ethnicity are some of the personal characteristics known to be associated with the experience of statistics anxiety (Chew & Dillon,

2014b; Macher et al., 2013; Onwuegbuzie & Wilson, 2003; Paechter et al., 2017).

Among these, gender is the most widely studied personal characteristics in statistics anxiety research (Baloğlu, 2003).

Gender differences: Many studies have focused on the association between gender and statistics anxiety. These results have been largely mixed. For example, based on the results of the structural equation modeling approach, Macher et al. (2012) indicated that female undergraduate students acknowledged significantly higher anxiety levels than male undergraduate students. Similarly, Rodarte-Luna and Sherry (2008) reported a relatively weak but significant difference between women and men in relation to statistics anxiety wherein women were more anxious than men. However, Koh and Zawi (2014) reported that among postgraduate students women reported lower levels of statistics anxiety than did their male counterparts. In a cross-cultural study using Turkish and American student samples, Baloğlu et al. (2011) reported that even after differences in grade point average and age were accounted for, significant gender and culture differences remained with respect to some but not all dimensions of statistics anxiety. Specifically, test and class anxiety and interpretation anxiety were significantly higher among women than men. In this study, however, there were no sex differences with regard to the dimensions of worth of statistics, computational self-concept, fear of asking for help, or fear of statistics instructors. Further, in comparison to Turkish students, American students were found to score higher on worth of statistics, interpretation anxiety, and fear of asking for help.

Age differences: As is the case for gender, there are conflicting findings concerning the role of age in the experience of statistics anxiety. Research published to date has sampled primarily undergraduate students in the age range of 18 to 56 years (mean ages less than 30 years). Some studies have determined, however, that older students report experiencing higher levels of statistics anxiety as compared to younger students (Baloğlu, 2003; Coetzee & Merwe, 2010; Liu & Haque, 2017) while others report no age-related differences (e.g. Bui & Alfaro, 2011).

As prior studies have offered conflicting findings with regard to how age and gender may moderate the experience of statistics anxiety and since few studies have included older individuals including graduate students, the purpose of the present study was to seek clarification by investigating gender influence on statistics anxiety among graduate students, after accounting for differences in age.

Method

Participants

Seventy-five graduate students pursuing various degrees at a mid-sized research university in the southeast United States participated in the present study. Graduate Students who registered for basic statistics courses were invited to participate. Students pursuing degree plans in a variety of fields were included in the study.

Instrument

Statistics anxiety was measured using the Statistics Anxiety Rating Scale (STARS) instrument (Cruise et al., 1985), which assessed six subscales: Worth of Statistics, Interpretation Anxiety, Test and Class Anxiety, Computational self-concept, Fear of Asking

for Help, and Fear of Statistics Teachers. The STARS is the most frequently utilized instrument in research concerning statistics anxiety (Onwuegbuzie & Wilson, 2003; Hanna et al., 2008; Chew & Dillon, 2014b; Cui et al., 2019). The STARS consists of 51 items utilizing a 5-point scale ranging from 1 = No anxiety to 5 = Strong Anxiety. The Worth of Statistics subscale (16 items) assesses students' attitudes toward the relevance of statistics (Cruise et al., 1985). Higher scores indicate more negative attitudes toward statistics. The Interpretation Anxiety subscale (11 items) assesses a student's anxiety when analyzing data and interpreting statistical results. The Test and Class Anxiety subscale (8 items) assesses anxiety experienced when taking statistics courses or tests. For both subscales, higher scores represent higher anxiety levels. The Computation Self-concept (7 items) measures a student's self-attribution concerning their ability to unravel statistics problems as well as a student's attitude toward mathematics. The higher the scale score, the more anxiety is felt when solving a statistics or math problem. The Fear of Asking for Help (4 items) is used to measure anxiety undergone when a student requests for help with statistics from a peer or instructor. Again, the higher the scores, the higher anxiety reported having been experienced. The Fear of Statistics Teachers (5 items) subscale measures the student's attitude toward statistics teachers. The higher the score, the more anxiety is felt toward statistics teachers. The STARS has been found to have high internal consistencies and test-retest reliabilities. Cronbach's alphas ranged from .68 to .94 across the six subscales. Test-retest reliabilities were computed with a period of five weeks intervening between initial and final testing, ranged from .67 to .83 (Cruise et al., 1985).

Procedure

Students were contacted using the University's student weekly email notification system soliciting their participation in the present study and providing a link to the online hosting site, Qualtrics, where those who volunteered to participate completed and submitted the online questionnaire. Student participation was also solicited directly in graduate statistics courses. For the in-class procedure, students who wished to participate completed and submitted hard-copy questions in the classroom. All data were anonymous. SPSS software was used to analyze the data. Parametric assumptions, normality, and homogeneity of variance assumptions were used to screen the data. The six subscales of the STARS constituted the dependent variables. Gender was the independent variable. Multivariate analysis of covariance (MANCOVA) was conducted with age as the covariate. As a follow-up test for significant main effects, descriptive discriminant analysis was conducted.

Results

The results indicated high internal consistency (alpha) values for all measures of statistics anxiety: Worth of Statistics (.96), Interpretation Anxiety (.88), Test and Class Anxiety (.85), Computational Self-concept (.85), Fear of Asking for Help (.86), and Fear of Statistics Teachers (.77).

Sample Characteristics

Of the sample, 49 (65.3%) identified as females and 26 (34.7%) males. The average age of the participants was 34 years ($SD = 9.65$). The participants' age range was 22 - 59 years. A variety of majors were represented in the present sample with the majority (62.5%) of participants pursuing degrees in

Psychology or Education-related disciplines. The other students were from various disciplines including Communication, Geography, Social sciences, Kinesiology, Communication, Technology, and Sciences- related discipline. Of the sample, the majority of students identified as White/Caucasian (76%), followed by Black/African American (9.3%), Latino/Hispanic (8%), Asian/Pacific Islander (4%), and Other (2.7%).

Descriptive analysis and Pearson correlations (Table 1) were conducted for the variables for the sample as a whole. The results showed that all statistics anxiety subscales were significantly correlated with one

another ($p < .01$). Worth of Statistics significantly correlated with Computational Self-concept which was the highest ($r = .76, p < .01$), the second-highest was between Computational Self-concept and Fear of Statistics Teachers ($r = .74, p < .01$), and the lowest correlation was between the subscales of Interpretation Anxiety and Fear of Statistics Teachers recorded the lowest value ($r = .31, p < .01$). Age was found to be positively correlated with the Test and Class Anxiety ($r = .33, p < .01$), Computational Self-concept ($r = .24, p < .05$), and Fear of Asking for Help ($r = .24, p < .05$) subscales. A significant negative point biserial correlation was found between gender and Fear of Asking for Help ($r_{pb} = -.27, p < .05$).

Table 1
Descriptive Statistics and Correlations for Study Variables

Variable	All students		Correlation						
	M	SD	1	2	3	4	5	6	7
Statistics Anxiety									
1. Worth of Statistics	1.83	0.84	-						
2. Interpretation Anxiety	2.43	0.75	.357**	-					
3. Test and Class Anxiety	3.15	0.90	.532**	.638**	-				
4. Computational Self-concept	2.01	0.96	.762**	.468**	.646**	-			
5. Fear of Asking for Help	2.23	1.07	.332**	.471**	.559**	.423**	-		
6. Fear of Statistics Teachers	2.06	0.77	.620**	.314**	.530**	.736**	.415**	-	
7. Age(years)	34.07	9.65	.048	.126	.333**	.236*	.245*	.138	-
8. Gender	-	-	.124	-.024	-.031	.131	-.271*	-.048	.148

* $p < .05$. ** $p < .01$.

Independent samples t-tests were conducted to explore possible gender differences in statistics anxiety across the six subscales of the STARS. The significant value was set to .0085 to control for the familywise error rate. Table 2 shows the means, standard deviations, t-test results, and effect sizes for the subscales and the age distribution of the two groups. Using this rigorous

significance criterion, none of the subscales were found to be statistically significantly different between males and females. It is noted, however, that females reported somewhat higher mean anxiety levels than did males for Worth of Statistics ($M_{females} = 1.91, SD = .89; M_{males} = 1.69, SD = .72$), and Computational Self-concept subscales ($M_{females} = 2.10, SD = 1.00; M_{males} =$

1.83, $SD = .87$). Males reported higher mean anxiety levels than females for the other four subscales.

Based on Cohen's (1988) effect size criterion, a medium effect size was found for Fear of Asking for Help. But effect sizes for Interpretation Anxiety, Test

and Class Anxiety, and Fear of Statistics Teachers were quite low indicating that both groups showed similar anxiety levels for those subscales. Overall, the highest reported anxiety levels were on the Test and Class Anxiety subscale for both groups.

Table 2

Univariate Analysis and Effect Size for STARS Subscales

Variable	Males		Females		$t (73)$	p	Cohen's d
	M	SD	M	SD			
Statistics anxiety							
Worth of Statistics	1.690	0.724	1.906	0.888	-1.068	.289	-0.250
Interpretation Anxiety	2.456	0.743	2.419	0.757	0.201	.841	0.047
Test and Class Anxiety	3.188	0.706	3.129	0.996	0.264	.792	0.062
Computational Self-concept	1.835	0.872	2.099	1.004	-1.132	.261	-0.265
Fear of Asking for Help	2.628	0.968	2.020	1.077	2.407	.019	0.563
Fear of Statistics Teachers	2.106	0.644	2.029	0.830	0.413	.681	0.097
Age(years)	32	7	35	10	-1.271	.163	-0.298

Note. Males ($n = 26$) and Females ($n = 49$).

Multivariate analysis of covariance (MANCOVA) was used to explore gender differences in statistics anxiety after accounting for age as a covariate. Before conducting MANCOVA, the assumption of multivariate normality was evaluated using Mahalanobis distances. None of the probability values of Mahalanobis distances were less than .001. Therefore, the criterion for multivariate normality was reached for each of the STARS subscales. Box's M statistics were used to evaluate the homogeneity of covariance matrices. The Box's M value of 26.99 associated with a p value of .286 indicated that the homogeneity of covariance matrices assumption was met for the dependent variables. Further, the

homogeneity of regression slope assumption was met, $p = .858$. Thus, the omnibus test of MANCOVA was conducted using Wilks' Lambda criteria. This resulted in a significant multivariate main effect for gender on the combined subscales of statistics anxiety, Wilks' Lambda = .80, $F(6, 66) = 2.76$, $p = .019$, $\eta_p^2 = .20$. Thus, 20% of the variance in the combined dependent variable was accounted for by gender. Age showed a significant covariate effect on combined subscales of statistics anxiety, Wilks' Lambda = .79, $F(6, 66) = 2.92$, $p = .014$, $\eta_p^2 = .21$. Age accounted for 21% of the variance in the combined subscales of statistics anxiety.

Table 3*Standardized Discriminant Functions and Structure Coefficients for Gender*

	Coefficient	r_s	$r_s^2\%$
Worth of Statistics	-.266	-.271	7.33
Interpretation Anxiety	-.039	.051	0.26
Test and Class Anxiety	.027	.067	0.45
Computational Self-concept	-1.014	-.287	8.23
Fear of Asking for Help	.935	.610	37.22
Fear of Statistics Teachers	.640	.105	1.09

r_s Structure coefficient.

$r_s^2\%$ Percentage variance explained.

Descriptive discriminant analysis was performed to further explore the nature of the main effect of gender. The canonical correlation was found to be statistically significant, $R_c = .419$, $p = .035$. The canonical variance explained by the function was 17.56%. The canonical discriminant function was also statistically significant, $\chi^2(6) = 13.53$, $p = .035$. The group centroids of the statistics anxiety subscales indicated that males had a mean of .625 while females had a mean of -.332. Moreover, male students were higher in estimated marginal mean anxieties on Fear of Asking for Help ($M_{females} = 1.99$, $SE = .14$; $M_{males} = 2.71$, $SE = .20$), Interpretation Anxiety ($M_{females} = 2.41$, $SE = .11$; $M_{males} = 2.49$, $SE = .15$), Test and Class Anxiety ($M_{females} = 3.10$, $SE = .12$; $M_{males} = 3.22$, $SE = .17$), and Fear of Statistics instructors ($M_{females} = 2.02$, $SE = .11$; $M_{males} = 2.09$, $SE = .15$) compared to female students. Standardized discriminant function coefficients were used to determine variables that contributed to group separation (Table 3). Structure coefficients were also examined. Fear of Asking for Help was found to be the main determinant of gender differences. Male graduate students reported higher anxiety than female graduate students when asking for statistics help from a peer or professor instructor thus supporting the

results of the univariate analyses discussed above. The subscales, Worth of Statistics and Computational Self-concept made slight contributions to these gender differences. Females graduate students had higher scores on the Worth of Statistics and Computational Self-concept subscales than did Males.

Discussion

As prior studies have primarily sampled undergraduate students ranging in age from 18 to 57 years (mean ages less than 30 years) and as there have been conflicting findings with regard to gender differences, the purpose of this study was to investigate possible gender differences in statistics anxiety among graduate students enrolled in statistics courses. Thus, the present sample consisted of older students compared to samples utilized in prior studies. The results demonstrate that after accounting for differences in age, a statistically significant difference existed overall between male and female graduate students as indexed by a significant multivariate effect for the six subscales of the STARS. It is noted, however, that the effect size was relatively small. It is possible that this is in part due to the low power in the analyses due to the relatively small sample size and that with a larger sample, affording more power, a

stronger effect would emerge. Follow-up discriminant analysis revealed that on average, male graduate students reported higher levels of anxiety as compared to females particularly in regard to asking for help from an instructor or a peer. This finding supports those of Koh and Zawi (2014) and Hsiao and Chiang (2011) that male postgraduate students exhibited higher levels of anxiety toward statistics than did female postgraduate students.

The above-referenced findings with graduate students stand in contrast to studies that sampled primarily or exclusively undergraduate students. For example, Baloğlu et al. (2011) as well as Rodarte-Luna and Sherry (2008) reported significant gender differences in the experience of statistics anxiety in which women acknowledged higher statistics anxiety levels than did their male counterparts. Correspondingly, female undergraduate students reported significantly higher anxiety than male undergraduate students in a study conducted by Macher et al. (2012). All these three studies sampled younger students than did the present study. Specifically, respondents studied ranged in age from 18-57 years in Baloğlu et al., 18-50 years in Rodarte-Luna and Sherry, and 18-46 years in Macher et al. In further contrast to the present findings, Rodarte-Luna and Sherry reported that women higher degrees of anxiety than men on the Fear of asking for Help subscale of the STARS. Again, their sample was comprised primarily of undergraduate students (93.8%) which might be one of the reasons to this inconsistency.

The lack of statistically significant gender differences on some subscales of the STARS in the present study is itself noteworthy suggesting that graduate students in the present sample at least, are homogeneous with

respect to reported anxiety in the case of dimensions of statistics anxiety assessed by the STARS. Based on the results, the highest levels of reported anxiety were found the Test and Class anxiety subscale for men and women alike. This is similar to the findings of Baloğlu et al. (2011) and Rodarte-luna and Sherry (2008) in which both males and females reported the highest level of anxiety on this same subscale. Likewise, Mji (2009) reported that among their sample from a vocational technology institution, students reported the highest degrees of anxiety on the Test and Class Anxiety and Fear of Asking for Help subscales. In this regard then the present findings with graduate students support the results of previous studies with undergraduates that the highest anxiety reported was in the realm of test and class-related anxiety.

Another interesting finding in the present study is the significant multivariate covariate effect of age on the STARS subscales collectively. The correlations between age and each of the six statistics anxiety subscales were found to be positive indicating that among the present sample, reported levels of statistics anxiety increased with age. This is similar to the results reported by Baloğlu (2003) and Baloğlu et al. (2011) that older students reported higher anxiety levels than did younger students. In the present study, the highest intercorrelations among STARS subscales were between the Worth of Statistics and Computational Self-concept subscales. This finding is parallel to the finding of Baloğlu et al. who indicated that when students' anxiety regarding their ability to calculate statistics was high, their attitude toward the relevance of statistics was relatively low.

Limitations

There are several limitations to the present study. Limiting the external validity of the findings is the fact that like virtually all previous studies in the area of statistics anxiety, the present study used a convenience sampling procedure. Further, the study was descriptive in nature, therefore, inferences concerning causal relationships among variables are not warranted. In addition, like all survey research, the present study relied on self-report which may introduce a source of bias. Although potentially heuristic and in line with previous findings, the results of this study are not necessarily generalizable to the general population of graduate students. Hence, the external validity of the results is delimited. Relatedly and like the vast majority of studies conducted on statistics anxiety, the sample was relatively small and may have precluded the detection of additional gender differences that may exist in the population of graduate students.

Implications and Future Directions

Considering the limitations discussed above, the primary recommendation for future research is to utilize a probability-based sampling procedure of adequate size to lend sufficient power to the data analysis process and to allow the results to be generalized to the larger population of graduate students in the fields of behavioral science and education. Increased power in the data analysis process could highlight additional gender differences to those found in the present study. Further, future studies could utilize appropriate sampling procedures to investigate differences among undergraduate and graduate student populations, allow for comparisons of students of various ethnic backgrounds, cross-cultural comparisons, and so forth.

In terms of applications, as it was found that older students in the present study reported higher overall levels of statistics anxiety than did younger students, attention should be given to designing and delivering statistics courses that take into account the somewhat unique needs of students of varying ages and different genders in such a manner as to mitigate statistics-related anxiety as a barrier to content mastery and career preparation. Instructors can enhance the teacher-student collaborative environment by personalizing the instructional and learning processes through individual and small-group interactions in the form of study groups and online anonymous discussion forums on learning management systems that promote discussion and depth of processing outside the class so that students have more opportunities to interact with each other as well as with instructors in a relatively informal and non-threatening setting (Chew & Dillon, 2014a). Additionally, older students who are particularly anxious concerning statistics can be encouraged to seek assistance from existing resource centers at their universities so that they would have more opportunities to practice and fully comprehend statistics problems. Consideration could be given to establishing such resources on campuses where they have not existed. Instructors might do well to be sensitive to the possibility that male graduate students may experience higher levels of anxiety overall compared to their female peers and particularly with regard to asking for help from peers or instructors and may not take initiative in seeking needed assistance. Relatedly, Koh and Zawi (2014) reported that individual assignments followed by mid-semester and final semester examinations are the most preferred evaluation methods among postgraduate students. Instructors could use those evaluation methods in a formative rather than a summative

manner to help allay students' anxiety related to test and class activities that would otherwise trigger anxiety. Since students' attitudes toward relevance of statistics and attitude toward mathematics generally are known to contribute to gender-based differences in the experience of statistics anxiety, instructors could

incorporate real-life examples that could help to diminish students' negative attitudes and thus anxiety. These are but a few practical suggestions for helping to alleviate the experience of statistics anxiety and promote higher levels of student learning outcomes.

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Please Cite Edirisooriya, M. L., & Lipscomb T. J. (2020). Gender Influence on Statistics Anxiety among Graduate Students. *Journal of Research in Science, Mathematics and Technology Education*, 4(2), 223-234. DOI: <https://doi.org/10.31756/jrsmte.421>

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Received: 08 September 2020 ▪ Accepted: 06 January 2021